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(54) **Pellets and shot and their manufacture**

(57) Pellets and shot for ammunition are produced from tungsten tungsten alloy, or particles of tungsten held in a matrix of a setting plastics material, e.g., silicone rubber or polyethylene. The tungsten alloy may have a tungsten content of between 40% and 97%. Preferred alloys comprise: 50% W, 35% Ni, 15% Cu or 90% W, 7½% Ni, 2½% Cu. The shot comprising a plastics matrix is made by injection moulding or by extruding the material of the shot through small orifices, chopping the extruded strands and tumbling.

GB 2 149 067 A

SPECIFICATION

Pellets and shot and their manufacture

- 5 This invention relates to the manufacture of pellets or shot for ammunition.
- The pellets or shot used in shot gun cartridges, for example, are of lead and in recent years there has been increasing concern expressed about the toxic hazards of lead shot.
- 10 Attempts have been made to use steel as a substitute material, but with limited success.

- According to one aspect of the present invention, there is provided a pellet or shot for ammunition formed from a tungsten-rich material. Such a product can be formed from a composite of particles in a binding matrix material, or it can be formed as a tungsten alloy.

- 20 Such a product avoids the toxic dangers of lead shot, it can be produced in a range of specific gravities according to need, and its shape or size can be closely controlled in manufacture.

- 25 A high density form of shot can be manufactured from a tungsten-rich alloy, e.g., having the proportions by weight of tungsten 90%, nickel $7\frac{1}{2}\%$, copper $2\frac{1}{2}\%$. This alloy has a density substantially greater than that of lead and for the same propellant and shot charge will have a greater range than lead. A cartridge using such shot can be made more compact also because of the smaller volume occupied by a given mass of shot and propellant.

- 35 The tungsten content of the alloy can vary over a wide range, although it should not usually be more than 97% by weight unless precautions are taken to prevent damage by abrasion of the gun barrel. Conversely, there should be at least 40% tungsten by weight for the shot to have a sufficiently high density. Thus, an alloy containing 50% tungsten with 35% nickel and 15% copper by weight will have a density similar to that of lead. As a further example, with a 70% tungsten content by weight a specific gravity of 14gm/cc can be obtained without undue sacrifice of other qualities. In these alloys a variety of other metals such as iron can be used as alloying constituents in combination with or in place of nickel and/or copper. The following examples are illustrative:

55 Example 1

- An alloy is composed in the proportions by weight, of tungsten 90%, nickel $7\frac{1}{2}\%$, copper $2\frac{1}{2}\%$. Shot so formed, e.g. by pressing from the powdered constituents and sintering, has a density substantially greater than that of lead shot, and ammunition having the same propellant and shot charge will have a greater range than lead. An otherwise conventional cartridge using such shot can be made more compact because of the smaller volume occu-

ried by a given mass of shot and propellant.

Example 2

- Shot is pressed and sintered from constituents in the proportions by weight of 50% tungsten, 35% nickel and 15% copper. The alloy has a density similar to that of lead shot and can be used as a direct substitute therefor.

- 75 In these examples the shot can of course be of known shape and the pressing and sintering operations can be conventional in themselves, so that more detailed description is unnecessary.

- 80 The invention also provides a method of producing pellets or shot for ammunition comprising mixing particles of tungsten or a tungsten-rich material with a setting plastics material and forming the pellets or shot from the mixed material.

- 85 A lower density product can be produced at less cost by using this method. Nevertheless, depending upon the proportions of the components of the mixture, the material can be given a density comparable with lead.
- 90 Examples of suitable mixtures are as follows:-

Example 3

- Pre-compressed and crushed tungsten powder was sieved in a 100 mesh sieve to remove very fine particles and was mixed with silicone rubber (e.g. that produced under the Trade Mark Silcoset 152 by Imperial Chemical Industries PLC of Great Britain) in the proportions 97.1% by weight powder and 2.9% by weight silicone rubber in a paddle mixer. The resulting mixture could be formed by injection moulding or by extrusion and yielded a resilient material with a specific gravity of 10.6 gm/cc, i.e. close to the density of lead.

Example 4

- In the process of Example 1, 3.8% by weight silicone rubber was added to 96.2% by weight tungsten powder and yielded a material with a specific gravity of 9.6 gm/cc.

Example 5

- 115 In the process of Example 1, 7.2% by weight silicone rubber was mixed with 92.8% by weight tungsten powder to yield a material with a density of 8.8 gm/cc.

120 Example 6

- Tungsten or tungsten alloy powder prepared in the manner described in Example 1 was mixed with low density polyethylene (e.g. 8503 GUB1 produced by Du Pont of Canada) in the proportions by weight of 96% metal powder and 4% polyethylene. The mix was milled in a ball mill, then transferred to a chamber and heated to 260°C before being extruded through small orifices. The extruded material was allowed to cool and was broken

into small pieces to provide a suitable feed material for an injection moulding process. The material had a density of 9.6 gm/cc.

- A moulding process is preferably used with the tungsten-rich alloy as well as with the polymer-base mixes illustrated above to produce the shot or pellets in the required sizes, and preferably in spherical form. After removal from the moulds, any moulding flash that may have been formed at the meeting faces of the mould parts can be removed from the product, e.g. by tumbling.

It is alternatively possible to form the shot or pellets by extrusion through small orifices, chopping the extruded strands and tumbling.

- When using shot according to the invention to make up a shotgun cartridge, the other elements of the cartridge can be conventional and the cartridge can be otherwise manufactured in a conventional manner, so that no further description of the cartridge is required here.

CLAIMS

1. A pellet or shot for ammunition formed from tungsten or a tungsten-rich material.
2. A pellet or shot according to Claim 1, formed from a tungsten alloy having a tungsten content of between 40% and 97% by weight.
3. A pellet or shot according to Claim 2 containing between 50% and 90% tungsten by weight.
4. A pellet or shot according to any one of the preceding claims containing an alloy of tungsten with nickel and/or copper.
5. A pellet or shot according to Claim 4, wherein the alloy is composed of tungsten 90% by weight and the remainder said alloying constituent.
6. A pellet or shot according to claim 4, wherein the alloy is composed of tungsten 70% by weight and the remainder said alloying constituent.
7. A pellet or shot according to claim 4, wherein the alloy is composed of tungsten 50% by weight and the remainder said alloying constituent.
8. A pellet or shot according to any one of claims 1 to 7 containing particles of tungsten or a tungsten-rich material in a settable plastics matrix.
9. A pellet or shot according to Claim 8, wherein the plastics matrix is provided by a silicone rubber or a polyethylene.
10. A pellet or shot according to Claim 8 or Claim 9, wherein the particles are at least of a size such as to be retained by a 100 mesh sieve.
11. A pellet or shot according to any one of the preceding claims having a density at least substantially equal to that of lead.
12. A shot gun cartridge comprising pellets or shot according to any one of the preceding claims.

13. A method of producing pellets or shot for ammunition, wherein the pellets or shot are formed from a tungsten-rich material.

14. A method of producing pellets or shot for ammunition comprising mixing particles of tungsten or a tungsten-rich material with a setting plastics matrix material and forming the pellets or shot from the mixed material.

15. A method according to Claim 14, wherein the pellets or shot are formed by extruding a strand of the mixed material, chopping the strand to form bodies substantially the size of the finished product and tumbling the chopped bodies.

16. A tungsten-containing pellet or shot substantially as described herein.

17. A method of producing pellets or shot substantially as described herein with reference to any of the examples.

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